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Improving the Delivery of Water and Sanitation: A Model of Coproduction of Infrastructure Services

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SUMMARY

Over one billion people around the world do not have affordable access to clean water and sanitation facilities. Since these facilities have certain technological and economic characteristics that lead to their underprovision in markets, their provision is often viewed as a government responsibility. However, public delivery has often been inadequate because of lack of knowledge of users' preferences, fiscal failures, and shirking and corruption by civil servants. In response to these failures, international development agencies have begun to advocate a decentralized approach to the provision water and sanitation services that relies on coproduction by community members and civil servants. Coproduction refers to a joint effort of community members and civil servants to design and implement a water and sanitation service.

This paper presents a model of coproduction of water and sanitation services by community members and civil servants. The purpose of the paper is to analyze how the performance of coproduction depends on the behavior of community members and civil servants administering the program, and how such behavior can be influenced by proper incentive mechanisms.

The paper shows that coproduction does not necessarily yield the optimal level of services, since community members and civil servants tend to underprovide their inputs into the production process. The analysis also indicates that coproduction is likely to be greater in poor communities than in rich ones, since the opportunity cost of devoting time to coproduction is lower in poor communities. Given the tendency towards sub-optimality, designing service-based institutions--such as mechanisms for monitoring and sanctions and wage incentives for civil servants--is critically important. In addition, community-based institutions--such as the effectiveness of local organizations--are crucial determinants of performance.

I. INTRODUCTION[1]

Over one billion people--most of the world's poor--do not have affordable access to clean water and sanitation facilities. This increases sickness and morbidity, decreases available time and resources for productive activity and thereby reduces well-being. Since these services have certain technological and economic characteristics that lead to underprovision in markets, they are often viewed as a government responsibility. However, public delivery has often been inadequate because of lack of knowledge of users' preferences, fiscal failures, and shirking and corruption by civil servants.

In response to these failures, staff and clients of international development agencies have begun to advocate a decentralized approach to the provision of water and sanitation services that relies on coproduction by community members and civil servants (Briscoe and Garn 1995). This approach is based on lessons-learned from erstwhile projects (Garn 1987) and from emerging evidence on the role of institutions, participation, and social capital (Ostrom, Schroeder, and Wynne 1993; Isham, Narayan, and Pritchett 1995; Narayan and Pritchett 1996). Coproduced infrastructure services require a joint effort by community members and civil servants. In doing so, this approach recognizes the importance of incentives faced by these stakeholders and the role of institutions in affecting these incentives.

Previous work on coproduction (Whitaker 1980; Parks *et al.* 1982; Ostrom and Ostrom

[1] This paper was written in conjunction with a research proposal on testing the determinants of performance of decentralized water and sanitation projects. We thank Mike Garn and Mancur Olson for guidance; Hans Binswanger, Keith McLean, Suzanne Piriou-Sall, and Colin Gannon for comments and inputs on the proposal; Louis Poulequin and participants at a World Bank seminar for their helpful criticism of an earlier version of this model; and Andrew Steer, Elinor Ostrom, Norman Uphoff and other participants at the SEA session for feedback on this paper.

1987; Lam 1996; and Ostrom 1996) and case studies of decentralized water and sanitation services (Watson 1995; Watson and Jaggannathan 1995; Sara, Gross, and van den Berg 1995; Tavares 1995) document the promise--and the challenge--of this approach. In many communities with coproduced services, performance has clearly been improved. Where performance is less satisfactory, the existing literature illuminates the importance of system design, including the design of service-level institutions.

However, important questions about the determinants of performance of coproduced services remain unanswered. Will coproduction based on utility-maximizing behavior by different stakeholders yield the optimal level of services? Is coproduction more or less effective in relatively poor communities than in rich communities? What is the role of wage incentives for civil servants? What is the relative importance of service-based and community-based institutions?

To help to answer these questions, this paper presents a model of coproduction of water and sanitation services by community members and civil servants. The aim is to analyze how the performance of coproduction depends on the utility-maximizing behavior of community members and civil servants administering the program, and how such behavior can be influenced by proper incentive mechanisms.

This paper shows that coproduction does not necessarily yield the optimal level of services, since community members and civil servants tend to underprovide their inputs into the production process. The analysis also indicates that coproduction is greater in poor communities than in rich ones, since the opportunity cost of devoting time to coproduction is lower in poor communities. Given the tendency towards sub-optimality, designing service-based institutions--such as mechanisms for monitoring and sanctions and wage incentives for civil servants--is critically important. In addition, community-based institutions--such as the effectiveness of local organizations--are likely to be critical determinants of performance.

The paper proceeds as follows. Section II discusses market, collective action, and government failures associated with provision of water and sanitation services. Section III discusses the promise and challenges of coproduction. Section IV presents the model. Section V concludes with a brief discussion on the direction of future work, including empirical testing of the determinants of performance of decentralized infrastructure services.

II. MARKET, COLLECTIVE ACTION, AND GOVERNMENT FAILURES IN WATER AND SANITATION PROVISION

In much of the developing world, water and sanitation services either do not exist or function poorly because of inherent characteristics that complicate their provision. Whether the provision of a service is most efficiently coordinated through markets, collective action (defined as voluntary action by community members as a group), or government depends partly on its economic and technological characteristics, particularly the degree of rivalry and excludability and the presence of scale economies (Kessides 1993; Ostrom, Gardner and Walker 1994)[2].

Water and sanitation services are often non-rival and excludable--and are thus classified as

[2] Based on the presence or absence of rivalry and excludability, goods and services can be classified into four categories: private, public, toll, and common pool. See World Bank (1994) and Picciotto (1995) for a thorough discussion of the importance of these characteristics in the provision of infrastructure services and development projects.

toll goods.[3] Non-rival services can be consumed jointly by several people since "one man's consumption does not reduce some other man's consumption" (Samuelson 1954). Excludable services can exclude consumption by others at a relatively low cost. Water and sanitation services also often involve significant scale economies, which further complicates their delivery.

The next three subsections illustrate why markets, collective action, and government may fail to provide water and sanitation services at the optimal level.

A. Market Failure

Markets may fail to provide water and sanitation services at all because of scale economies related to production. These systems may require large, indivisible investments in networks which attach multiple nodes: where these indivisibilities are large and property rights are underdeveloped, private investors can not earn an adequate return and thus may fail to provide them. Furthermore, market prices cannot be used to ration non-rival services: if the service is non-rival, the marginal cost of additional users--and thus the market price of the service--is zero (Oakland 1987). When markets do provide water and sanitation services, they may not be provided at optimal levels in an unregulated market because of natural monopolies created by network provision or because of externalities.

[3] Some water and sanitation services are public goods--non-excludable and non-rival. This paper focuses only on services that are toll goods. The analysis of toll goods applies, however, also to local public goods which have a spatial dimension.

B. Collective Action Failure

Although a non-rival and excludable service can be optimally provided by the formation of a club (Buchanan 1965; Sandler and Tschirhart 1980), the provision of water and sanitation services through collective action may fail[4]. The reasons for failure often include high fixed costs or lack of technical knowledge and skills: community members in many regions may lack the required physical and human capital resources.

Since certain infrastructure services are non-rival and non-excludable, it is worth comparing these two cases. In the case of a pure public service, collective action may fail because of the free-rider problem. When a service is non-excludable, many community members will fail to contribute to its provision. The relative success of collective action in optimally providing the service depends on the size of the group, homogeneity of group members in terms of tastes and endowments, and the available communication technology. According to theory, collective action is likely to succeed when the group size is small (Chamberlin 1974; McGuire 1974) and when group members interact frequently, communicate easily, and share common values and beliefs. The larger is the group of beneficiaries, the less likely the service will be provided optimally through collective action (Dixit and Olson 1996)[5]. In general, collective action for non-rival and non-excludable goods will yield suboptimal provisions (Olson 1965; Hardin 1982; Sandler 1992).

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4 This club result holds assuming that exclusion costs do not exceed gains from allocating the service in a club arrangement.

5 Sandler (1992) points out that this outcome depends on the technology of supply.

C. Government Failure

Because of market and collective action failures, government intervention in the provision of infrastructure services is often justified. In theory, government can provide the pareto-optimal level of the service by using lump-sum taxation from community members as a selective incentive to coerce collective action. In practice, governments often fail to provide water and sanitation services optimally because of: non-availability of lump sum taxes; fiscal constraints due to a limited tax base; lack of knowledge of users' needs; and shirking and corruption by civil servants.

First, a government may fail to provide these services optimally because it must use distortionary taxes. Unlike lump sum taxes, distortionary taxes lead to a sub-optimal solution (Auerbach and Feldstein 1987).

Second, a government may have a limited tax base. In particular in developing countries, governments are often unable to collect tax revenues needed to satisfy demand for water and sanitation services.

Third, a government may not know community members' preferences. The traditional lump sum tax analysis assumes that the government has full knowledge of preferences. But in fact, the government does not have at its disposal all the requisite information[6]. As a result, government provision may not be optimal.

Finally, government may fail to provide these services optimally because of opportunistic behavior of civil servants. Shirking and corruption by civil servants is likely unless they work under

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6 As recognized by Samuelson (1954), an individual may have an incentive to understate demand for the service if the amount he has to pay for the service--under any payment scheme--is related to its "revealed preference".

well-designed incentive mechanisms (Wade 1988, 1994; Uphoff 1994). Civil servants may embezzle portions of tax revenues or other funds intended to finance the service (IRIS 1996): case studies from around the world indicate that illegal payoffs can increase the cost or lower the quality of public works projects by as much as 30 to 50 percent (Rose-Ackerman 1996).

Overall, these results raise a question: what can be done when markets, collective action, and governments fail to provide services at efficient levels?

III. THE PROMISE OF COPRODUCTION

Recently, a decentralized approach to the provision of water and sanitation services has emerged (Briscoe and Garn 1995) that relies on coproduction, defined as "a process through which inputs from individuals who are not in the same organization are transformed into goods and services" (Ostrom 1996). Coproduction in this paper refers to the production of water and sanitation services through a joint effort of community members and civil servants. Members of both groups contribute inputs into the production process: community members devote time to the design, operation, and maintenance of parts of the system; and civil servants oversee inputs provided by the government. Note that the government is not contracting community members to produce the service: they voluntarily "participate" by contributing inputs to thc production process.

Coproduction of water and sanitation services may alleviate government failure by: alleviating fiscal pressures on the government; providing a means of revealing community members' preferences; and increasing transparency and accountability within the government.

First, coproduction may relieve fiscal pressures. In general (as discussed below), inputs supplied by community members complement inputs supplied by civil servants. However, some tasks may be carried out equally well by members of either group. For inputs that are substitutable, the most efficient service production uses the least-cost producer[7]. The division of labor depends in that case on the government wage rate and the opportunity cost of a community member. In developing countries, the local reservation wage is likely to be lower than the wage rate of a government worker, so that some tasks should be reallocated.[8] This reallocation of labor would, *ceteris paribus*, both relieve the pressure on the government budget and increase the production of services.

Second, adopting coproduction may help to reveal community preferences and ensure that services match what community members want, are willing to pay for, and will be motivated to maintain. If community members devote time to the design, operation, and maintenance of water and sanitation facilities and thereby reveal their preferences, asymmetric information problems will be alleviated. Since community inputs complement inputs supplied by the government, production will shift towards the optimal level.

Third, coproduction may decrease the opportunities for shirking and corruption among civil servants by increasing transparency and accountability. When community members participate in the design, operation, and maintenance of services, the flow of information and the interaction among stakeholders reduces the opportunities for civil servants to embezzle tax revenues or other

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[7] Assuming that the producer would be motivated to work up to its capacity.

[8] As Ostrom (1996) has stated: "many poor regions and neighborhoods are characterized by severe underutilization of the knowledge, skills, and time of residents--which means the opportunity costs of devoting these inputs to the creation of valued public outputs are low."

funds allocated for public works.

IV. A MODEL OF COPRODUCTION

The analysis of coproduction of water and sanitation services is carried out with a modified version of the household production model (Becker 1965; Michael and Becker 1973). The model explores how utility-maximizing behavior by community members and civil servants determines the performance of coproduced infrastructure services. By focusing on their joint provision of inputs, the model shows how certain failures of collective action and of government are reduced--but not eliminated--by the adaptation of coproduction.

In order to focus on the performance of infrastructure services in a community and the local incentives for reducing shirking and corruption, this model abstracts away from the first two means of alleviating government failure discussed in the previous section. First, it ignores fiscal constraints on the central government: public capital is assumed to come from tax receipts and/or foreign aid. Second, the model takes as given the decision by households to undertake a coproduced activity: each community member's willingness to pay for the infrastructure service is assumed to be equal to an imposed user fee.

A. Set-up of the model

Assume that a central government has budgeted a fixed amount of public capital for decentralized water and sanitation services in selected peri-urban and rural communities. The analysis focuses on a community of n identical community members which has been deemed eligible for such a service and has decided to adopt it.[9] By agreeing to contribute a community share V of funds, they will receive a fixed amount X of this public capital from the central government that can be used as physical inputs in the coproduction of the infrastructure service.[10] Each of the n community members will pay a user fee v ($v \equiv V/n$) for the right to use the non-rival water and sanitation service Q. In addition, each community member devotes a share α_i, $\alpha_i \in (0,1)$, of her time t_i to the coproduction of the infrastructure service; the remaining share $(1-\alpha_i)$ is allocated to income-earning labor at a fixed wage rate w_i. Time allocated to the infrastructure service provision goes towards the design, operation, and maintenance of the water and sanitation system. Therefore, a representative community member maximizes utility by choosing a level of private consumption y_i at a fixed price p and by allocating her time t_i between infrastructure service provision and wage earning as follows:

$$(1) \quad \begin{aligned} &\underset{y_i,\alpha_i}{Max}\ U_i(y_i\,,\,Q)\,, \quad i=1,\ldots n \\ &s.t. \\ &py_i + v = w_i(1-\alpha_i)t_i \end{aligned}$$

where U_i is increasing and concave in y_i and Q. Since Q is non-rival, the aggregate amount enters into her utility function. Each individual is assumed to take others' behavior as given.

A single civil servant is assumed to administer the government inputs: public capital X and

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9 For analytical tractability, n is given in the model. It is assumed for simplicity that there is no congestion. Relaxing this assumption would allow to analyze the optimal group size related to congestion.

10 See Garn (1995) for a discussion of the suggestion that community eligibility be necessary but not sufficient condition for provision of public finances.

his time as a government official.[11] He differs from community members in three important ways: he does not live in the community and is therefore not affected by the provision of the infrastructure service; he receives a wage from the central government, not from local labor opportunities; and he has opportunities to expropriate some of the public capital for his own use.

Specifically, the civil servant expropriates a portion E of the public capital X received from the central government. He will allocate a share (1-β), $\beta \in (0,1)$, of his time t_g to the provision of the infrastructure service and a share β to expropriation of the public capital. The greater is this share, the greater is shirking and corruption . The amount E of public funds expropriated is assumed to depend on the time that he allocates to expropriation and on the aggregate time that community members allocate to the provision of infrastructure services:

$$(2) \qquad E = E\left(\beta t_g\ ,\ \sum \alpha_i t_i\right),\quad i=1,\ldots n$$

E is assumed to be increasing in βt_g and decreasing in the sum of $\alpha_i t_i$: the more involved is the community in coproduction, the less public capital will the civil servant be able to expropriate. As a result, the actual amount of public capital X_a used in the coproduction of the infrastructure service is:

$$(3) \qquad X_a = X - E\left(\beta t_g\ ,\ \sum \alpha_i t_i\right),\quad i = 1,\ldots n$$

The amount of infrastructure service Q available for the n community members will thus be determined by their provision of time, the civil servant's provision of time, and the actual supply of public capital. The coproduction technology is:

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[11] Under some circumstances, a representative of an NGO may replace the civil servant, depending on the institutional design. The analysis presented here applies also to those cases.

$$(4) \qquad Q = f\left(X_a + V \ , \ (1-\beta)t_g \ , \ \sum \alpha_i t_i \ , \ k_1 \ , \ k_2 \right), \quad i=1,...n$$

where f is increasing and concave in all inputs and exhibits constant returns to scale. Following Ostrom (1996), all three inputs are assumed to be complements. k_1 and k_2 are fixed inputs: k_1 denotes service-based institutions that affect behavior by community members and the civil servant (for example, monitoring and sanctions mechanisms); k_2 denotes corresponding community-based institutions (for example, level of activity of local organizations).

The civil servant maximizes utility by choosing a level of private consumption y_g at price p and expropriation E. He allocates time between coproduction and expropriation activities as follows:

$$(5) \qquad \begin{array}{l} \underset{y_g, \beta}{Max} \ U_g(y_g \ , \ E) \\ s.t \\ p y_g = w_g t_g + \theta Q \end{array}$$

where $w_g t_g$ is a guaranteed wage payment and θQ is an incentive payment that is increasing and, for simplicity, linear in Q. U_g is increasing and concave in y_g and E.

The civil servant devotes time to expropriation until its marginal cost--the lost incentive payment--is equal to its marginal benefits. This can be seen from the first order conditions for civil servant's maximization problem that give:

$$(6) \qquad MRS_{Ey}^{g} = \frac{\theta \left(\frac{\partial f}{\partial (X_a + V)} \frac{dE}{d(\beta t_g)} + \frac{\partial f}{\partial (1-\beta) t_g} \right)}{p}$$

where $MRS_{Ey}^{g} \equiv B(\partial U_g/\partial E)/(\partial U_g/\partial y_g)$ and $B \equiv dE/d(\beta t_g) > 0$. Increasing the share of time going to expropriation, decreases civil servant's time available for coproduction. As a result, the incentive payment received goes down.

Each community member's allocation of time to the provision of infrastructure services depends on her opportunity cost, the local wage rate. The first order conditions from community member's problem yield:

$$(7) \qquad MRS^{i}_{Qy} = \frac{w_i}{p}, \quad i = 1,...n$$

where $MRS_{Qy}{}^{i} \equiv A(\partial U_i/\partial Q)/(\partial U_i/\partial y_i)$ and $A \equiv [(\partial f/\partial \sum \alpha_i t_i)-(\partial f/\partial (X_a+V))(dE/d\sum \alpha_i t_i)] > 0$. Equation (7) indicates that each community member allocates time to coproduction until the marginal cost of another unit of service measured in terms of the private good is equal to its marginal benefits. The marginal cost of Q equals the local wage rate w_i, labor income forgone.

B. Implications of the model

Underprovision by community members and the civil servant: Where service-based and community-based institutions are weak, the coproduced service will be underprovided. Without appropriate incentive mechanisms, coproduction may not improve the provision of infrastructure services.

Without additional incentives, community members will provide sub-optimal amounts of time. This can be seen by solving the social planner's problem--where each community member provides time at the optimal level and the civil servant devotes all of his time to coproduction--and comparing the resulting first order condition

$$(8) \qquad \sum MRS^{i}_{Qy} = \frac{w_i}{p}, \quad i = 1,...n$$

associated with the Pareto optimal Q^* with the first order condition associated with the Nash equilibrium Q^N (from equation 7). Using equation (7) to evaluate (8) implies that $Q^N < Q^*$, since the utility function is strictly concave. Non-optimality results from the assumed Nash behavior of community members: each individual does not recognize the benefits conferred on others from her own behavior.

Likewise, without the proper incentive scheme, the civil servant will devote a relatively large amount of time towards expropriation. The civil servant is assumed to receive an incentive payment θQ, which is increasing in Q. It can easily be seen from equation (6) that if θ is very low, the civil servant will devote most of his time to expropriation since its marginal cost is low.

This tendency towards sub-optimal coproduction is illustrated in figure 1. The axes denote time inputs from community members and the civil servant. The isoquant $Q^*|x$ denotes the highest technically achievable coproduction with the fixed public input X and combinations of time inputs from the community and the civil servant. The social planner's outcome is denoted by point A: given budget and time constraints, this is the pareto-optimal solution to coproduction of this service. The sub-optimal Nash equilibrium is denoted by point B: in this equilibrium, community members underprovide time, and the civil servant shirks and pursues corruption. Output from coproduction is directly lowered because of the reduction of time inputs (B is closer to the origin) and further indirectly lowered because of the diversion of public capital through expropriation. The indirect effect is captured by point B falling on an isoquant ($Q^{**}|x_a < x$) associated with the social planners problem that corresponds to inputs of physical capital $X_a < X$.

<u>Levels of provision in poor and rich communities</u>. In low-income communities, coproduction will be greater than in high-income communities. Where the reservation wage is low, the marginal cost of devoting another unit of time to coproduction is low, so that more time will be

allocated to the provision of the infrastructure service. This can be seen from equation (7), which indicates--by the strict concavity of the utility function--that poor community members (in terms of wage income earned per unit of time) will devote more time to the provision of the infrastructure service than rich ones.

Figure 2 depicts a representative individual's utility from the infrastructure service and the private good. Point A corresponds to consumption choices of a representative individual in a community with relatively low wages, and point B to such choices in a community with relatively high wages. In each case, the levels of consumption will be chosen such that the marginal rate of substitution between the service and the private good equals the ratio of the reservation wage to the price. As indicated, the poor individual will choose more of the service and less of the private good.

Figure 3 shows the implications of this choice on the output of the coproduced service. *Ceteris paribus*, since individuals in poor communities devote more time to coproduction, their aggregate community input will be greater than in rich communities. In addition, since this will reduce the return to expropriation by the civil servant, he will also increase his allocation of time towards coproduction, and the total amount of expropriated funds will decrease[12].

These first two implications illustrate the tendency towards underprovision by community members and the civil servant. As such, the model confirms that the major challenge of coproduction is the design of service-based institutions to induce collective action among community members and to increase accountability among civil servants.

<u>The design of service-level institutions</u> Effective "rules of the game" designed for the

[12] Again, this indirect effect will be capture diagrammatically by point B falling on an isoquant associated with more actual public inputs X_a.

infrastructure service will help to move individual provision from the Nash equilibrium towards the pareto-optimal solution. In many cases, this includes service-level institutions on collective-choice arrangements, monitoring, sanctions, and dispute resolution mechanisms (Ostrom 1992). Where community members agree *ex ante* to the adaptation of a coproduction technology that requires high levels of community inputs (Garn 1995), such institutions will encourage individuals to hold to these commitments. In this model, these institutions are captured by the fixed input k_1: the more effective are these institutions, the greater will be the output of coproduced services[13].

Among the institutions that can be designed at the service-level are incentive payments for the civil servant. Equation (6) indicates that one way to induce the civil servant to devote more time to coproduction and less to expropriation is by increasing θ, the size of the incentive payment. Increased θ will raise the marginal cost of expropriation and, thereby, reduce the civil servant's time allocation to corruption.

The importance of community-level institutions Existing institutions within communities will also help to move individual provision from the Nash equilibrium towards the pareto-optimal solution. In communities where the level of overall civic activity is high, local organizations will encourage individuals to provide the optimal amounts of time and discourage civil servants from shirking and corruption. In this model, these institutions are captured by the fixed input k_2: the more effective are these institutions, the greater will be the output of coproduced service. A rich literature on social capital is emerging--informed by early empirical work on local organizations (Esman and

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[13] The nature of institutions in this model has a *deus ex machina* quality. However, without a parsimonious way to model the evolution of such institutions, they are introduced exogenously. In the future, this will allow for empirical testing of the relative importance of service-based and community-based institutions in determining performance.

Uphoff 1984)--that documents the importance of these community-based institutions for performance (Putnam 1993; Narayan and Pritchett 1996). With an empirical test of this model, the relative importance of these institutions can be explored by comparing their effects with other determinants of performance, including service-level institutions.

V. CONCLUSION

This paper has analyzed the promise and challenges of decentralized water and sanitation services by presenting a model of coproduction. The model was used to study how service performance depends on the utility-maximizing behavior of members of communities and public agencies.

The model illustrates how certain failures of collective action and government are reduced--but not eliminated--by the adaptation of coproduction. It was shown that community-members and civil servants tend to underprovide their inputs into coproduction. The analysis also indicates that performance of coproduction is better in relatively poor communities. Finally, service-based institutions (including wage incentives for civil servants) and community-based institutions are critical determinants of performance.

In future work, this model will be extended in two ways. First, in order to explore the optimal group size for coproduction, the congestion factor will be included so that the optimal group size is endogenized. Second, in order to analyze the ramifications of coproduction of non-rival and non-excludable services (like rural feeder roads), the model will be modified.

Finally, planned future work also includes empirical testing of this model with data from ongoing decentralized and coproduced water and sanitation services financed by the World Bank. For example, in the Yacupaj Project in Bolivia, communities with populations between 50 and 250 inhabitants are coproducing water and sanitation services (Sara, Gross, and van den Berg 1995). The testing of the model will require data on the supply of inputs to coproduction, prices and wages associated with service provision, service-level institutions, and community-level institutions[14]. Empirical results on the determinants of performance would help policy makers and their clients to further improve the design of coproduced infrastructure services.

[14] The plan is to collect this data by abbreviated household surveys, with a modified version of the systematic case review method (Finsterbusch 1990) for measuring the more qualitative data. This method, which was designed to transform qualitative phenomena into data suitable for statistical analysis, has been used successfully in the evaluation of development projects (Finsterbusch and Van Wicklin 1987; Narayan 1995) and withstood three possible strong econometric objections (Isham, Narayan, and Pritchett 1995).

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Figure 1: Pareto-Optimal and Nash Provision of Coproduction

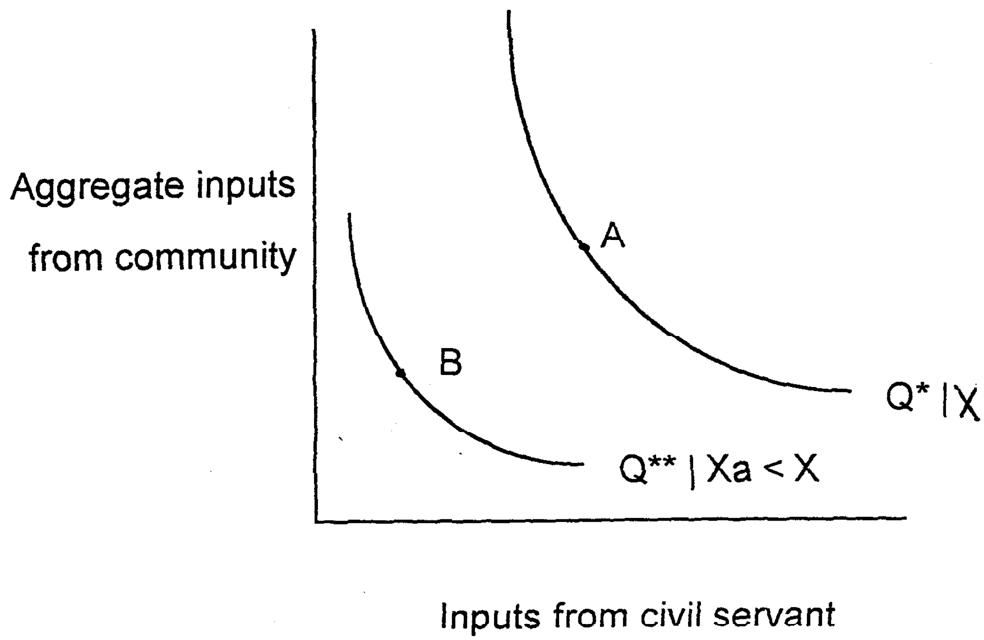

Figure 2: Infrastructure and Private Consumption in Poor and Rich Communities

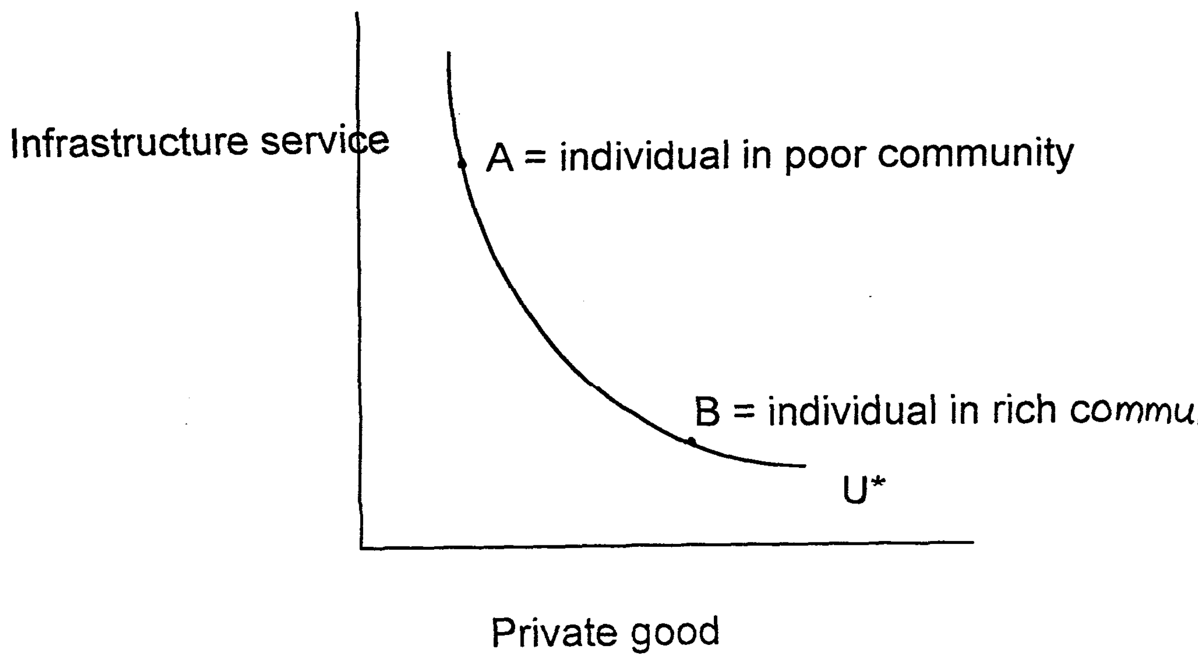

Figure 3: Coproduction in Rich and Poor communities